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Prevention of Bridge Scour with Non-uniform Circular Piers Plane under Steady Flows

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River bed scour and deposit variation extremely severe because of most of rivers are steep and rapid flows, and river discharge extremely unstable and highly unsteady during different seasons in Taiwan. In addition to the obstruction of piers foundation, it causes local scour and threatens the safety of bridges. In the past, riprap, wire gabion or wrap pier works were adopted as the protections of piers foundation, but there were no effectual outcomes. The events of break off piers still happen sometimes. For example, typhoon Kalmaegi (2008) and Morakot (2009) caused heavy damages on Ho-Fon bridge in the Da-jia river and Shuang-Yuan bridge in the Kao-Ping river, respectively. Accordingly, to understand the piers scour system and propose an appropriate protection of piers foundation becomes an important topic for this study currently.

This research improves the protection works of the existing uniform bridge pier (diameter D) to ensure the safety of the bridge. The non-uniform plane of circular piers (diameter D*) are placed on the top of a bridge pier foundation to reduce the down flow impacting energy and scour by its' surface roughness characteristics. This study utilize hydraulic models to simulate local scour depth and scour depth change with time for non-uniform pier diameter ratio D/D* of 0.3,0.4,0.5,0.6,0.7 and 0.8, and different type pier and initial bed level (Y) relative under the foundation top elevation under steady flows of V/Vc=0.95,0.80 and 0.65.

The research results show that the scour depth increases with an increase of flow intensity (V/Vc) under different types of steady flow hydrographs. The scour depth decreases with increase of initial bed level (Y=+0.2D*,0D*and -0.2D*) relative under the foundation top elevation of the different type pier. The maximum scour depth occurred in the front of the pier for all conditions.

Because of the scouring retardation by the non-uniform plane of foundation, the scour depth is reduced for the un-exposed bridge foundation (Y=+0.2D*) under any steady flows. Opposite results are found for the exposed (Y=-0.2D*) bridge foundation. For the condition non-uniform pier diameter ratio (D/D*=0.3∼0.8) scours, when D/D* is equal to 0.4, because pier oncoming flow area is the smallest one so that down flow intensity is less; as non-uniform area is bigger and decrease more down flow energy so that bring smaller scour depth and effect area. Therefore, local scour depth for pier diameter ratio of 0.4 is less than other type of pier. Considering the safety of bridge structure, a non-uniform circular pier with D/D* which equals to 0.4 and initial bed level relative to Y=+0.2D* is the most ideal pier allocations.